Environment

Adding to acid fog

Water droplets in fogs that blanket parts of southern California often carry a heavy load of chemical acids, according to research conducted over the last few years at the California Institute of Technology in Pasadena. Frequently, the acidity of these fogs may be 100 times that typically found in acid rain. In one extreme case, a relatively light fog at Corona del Mar reached a pH of 1.7 — equivalent to the acidity of some toilet bowl cleaners.

The principal culprit is sulfur dioxide, usually generated by the burning of crude oil at local oil fields. When this gas dissolves in water drops, it is rapidly converted to sulfuric acid. But the chemistry in a fog or cloud water droplet is actually more complicated than this.

In the Jan. 17 SCIENCE, Caltech's Michael R. Hoffmann and his colleagues report that the hydroxymethanesulfonate (HMSA) ion ($CH_2O{:}HSO_3^-$) probably also plays an important role. Measurements at Bakersfield, Calif., confirm the presence of HMSA, which appears to form when the concentration of sulfur dioxide is high, as it would be near oil fields. Formation of this ion may account for the subsequent observation of traces of formaldehyde (CH_2O) in fogs and clouds.

Bhopal: The official view

After a long delay, the government of India has released the results of its investigation into the causes of the tragic methyl isocyanate vapor leak from a Union Carbide plant in Bhopal, India (SN: 12/15/84, p. 372). The report suggests that more than 1,000 pounds of water entered a tank containing methyl isocyanate. This largely agrees with Union Carbide's findings (SN: 3/30/85, p. 196).

However, the report says that contaminating metal ions also had to be present. These contaminants acted as catalysts, setting off a series of explosive, water-induced chemical reactions that rapidly raised the mixture's temperature. Union Carbide maintains that the runaway reaction was set off by the presence of chloroform. How the metal contaminants and water got into the tank is still unclear and may never be settled.

Nitrogen and acid soils

Acid precipitation, as rain or snow, has been shown to affect freshwater lakes and streams and possibly forests. It may also contribute to making agricultural soils more acidic. However, a report in AMBIO (Vol. 14, No. 6) indicates that fertilizers rich in ammonium ions in particular, together with the enhanced biological activity promoted by any nitrogen fertilizer, acidify soil more than acid deposition does. "Thus, nitrogen may present a threat to the long-term health of the soil," Lars Bergström and Arne Gustafson of the Swedish University of Agricultural Sciences in Uppsala say in the report.

Airborne nutrients for forests

The dry deposition of airborne particles and vapors provides a large fraction of the nutrient needs of trees in a hardwood forest in the eastern United States, say a group of researchers at the Oak Ridge (Tenn.) National Laboratory in the Jan. 10 SCIENCE. Atmospheric deposition supplies more than 100 percent of sulfur requirements and about 40 percent of nitrogen and calcium requirements for annual tree growth.

"If these proportions are raised because of increased industrial and automotive emissions," the researchers say, "forests may satisfy increasing portions of their nutrient requirements by assimilation of airborne material, while simultaneously being exposed to increasing levels of air pollutants." The effects of excess sulfur, nitrogen and trace metal deposition may already be visible in the observed decline of high-elevation forests (SN: 4/13/85, p. 228).

Science & Society

NMR patent: A matter of infringement

In 1974 Raymond V. Damadian, a physician, patented the design and use of a nuclear magnetic resonance (NMR) imaging device to scan the body in search of cancer. Since then, NMR scans — now known as magnetic resonance imaging (MRI) scans — have become a standard diagnostic technique employed by large hospitals and medical clinics throughout the world. However, only about 30 of the estimated 250 MRI machines in medical use have been made by Damadian's company, the Melville, N.Y.-based Fonar Corp. Since no one sought a license from Fonar to manufacture the device, Damadian reasoned that makers of those other machines must be infringing on his patent. He sued one such company. And in late November 1985, a jury in a Massachusetts federal district court case ruled that Johnson & Johnson Inc.'s Cleveland-based Technicare subsidiary — maker of 100 MRI medical devices — had indeed infringed upon Damadian's patent. But on Jan. 10, the judge overturned the finding of infringement, saying that, based on the evidence, the jury had rendered an invalid judgment.

The judge's ruling, which Fonar will appeal, seems to hinge on a scientific issue: Do physicians using NMR diagnose diseases — like cancer — based upon a comparison of the time it takes excited hydrogen nuclei in diseased and normal tissue to "relax" back to their ground state?

Although the spin orientation of atomic nuclei in the body is usually random, those spins will line up in a north-south polar orientation when the nuclei are acted on by a magnetic force. In NMR, such a magnetic force is applied to body tissue. Then a radio wave signal with a frequency that will be absorbed by hydrogen nuclei is beamed at the tissue. Nuclei absorbing this energy become excited, altering their alignment. When the radio signal stops, the nuclei relax back to their previous magnetic-field alignment. MRI devices measure the time it takes excited nuclei to relax, and display with a similar contrast regions having the same relaxation time. These relaxation times are known as T1 and T2 (based on orientation — transverse or longitudinal — of the magnetic field used to align the nuclei).

Research by Damadian has shown that the T1 and T2 were longer for hydrogen nuclei in diseased tissue, like cancer, than in normal tissue. And the patent at issue in this case specifies use of T1 and T2 to discriminate between diseased and normal tissue.

But in reversing the jury verdict of patent infringement, U.S. District Court Judge Robert E. Keeton said that an MRI device "need not, and does not as routinely used, compute T1 and T2 values." Moreover, he wrote, though T1 and T2 are by far the greatest contributors to MRI signal strength, "neither that particular value [of signal strength], nor the value of any component that contributes to it, is itself significant to imaging." In fact, he said, detecting cancer with an MRI machine depends not on T1 and T2 "but instead upon inferences of a diagnostician from the shapes and locations of images, and from the diagnostician's comparison of images rather than comparison of T1 and T2 values." Therefore, he said, Technicare's MRI machines do not infringe on Damadian's patent.

According to Damadian, "That interpretation by the judge is nonsense," because "when you make an [NMR] image, the image is of T1 and T2." So the difference in those values for normal and abnormal tissue is integral to a diagnostician's use of any commercial MRI system, Damadian maintains — "and there was never any testimony [in the trial] contrary to that."

"We feel confident that the judge's decision will be reversed and the jury verdict reinstated," says John Nelson, an attorney representing Fonar and Damadian. But even winning the appeal would not settle the issue: Deciding what "reasonable royalties" the patent infringer owed could take another year.